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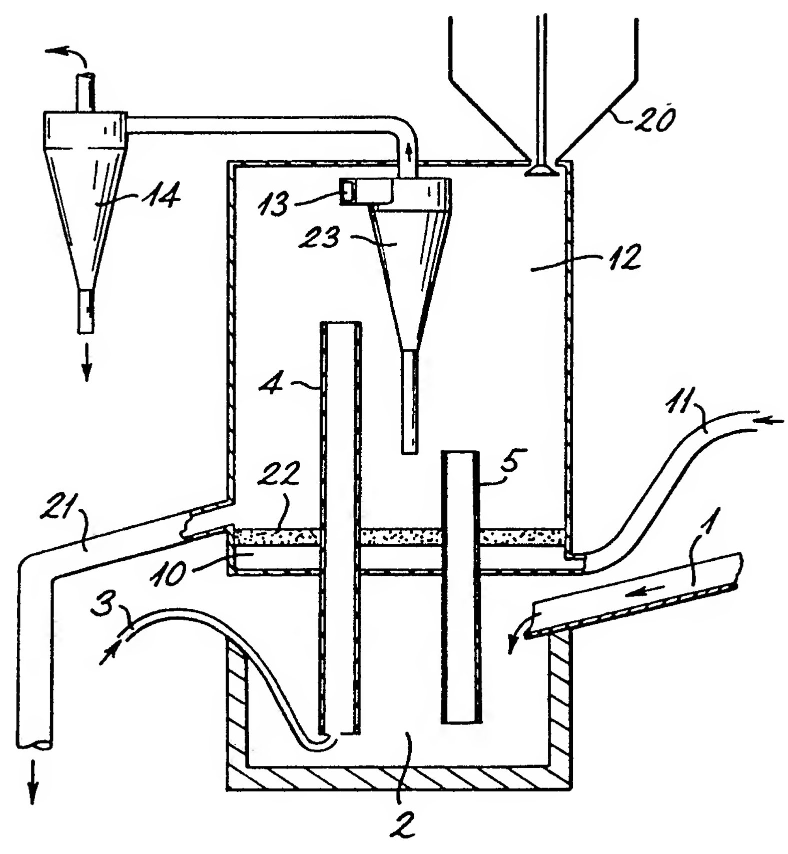
(54) Countercurrent gas treatment of metallurgical melts

(57) A metallurgical melt such as a sulphide matte or an impure metal in a vessel 1 is raised by lift gas from a lance 3 up a snorkel 4 into a reduced-pressure vessel 12, where it falls as droplets countercurrently to a scavenging gas from a supply 11 rising through a gas-permeable floor 22 upwardly through the vessel 12 to a cyclone cleaner 14 and pump.

The vessel 12 may contain a packed bed of scrap iron, replenished from hopper 20 as it dissolves.



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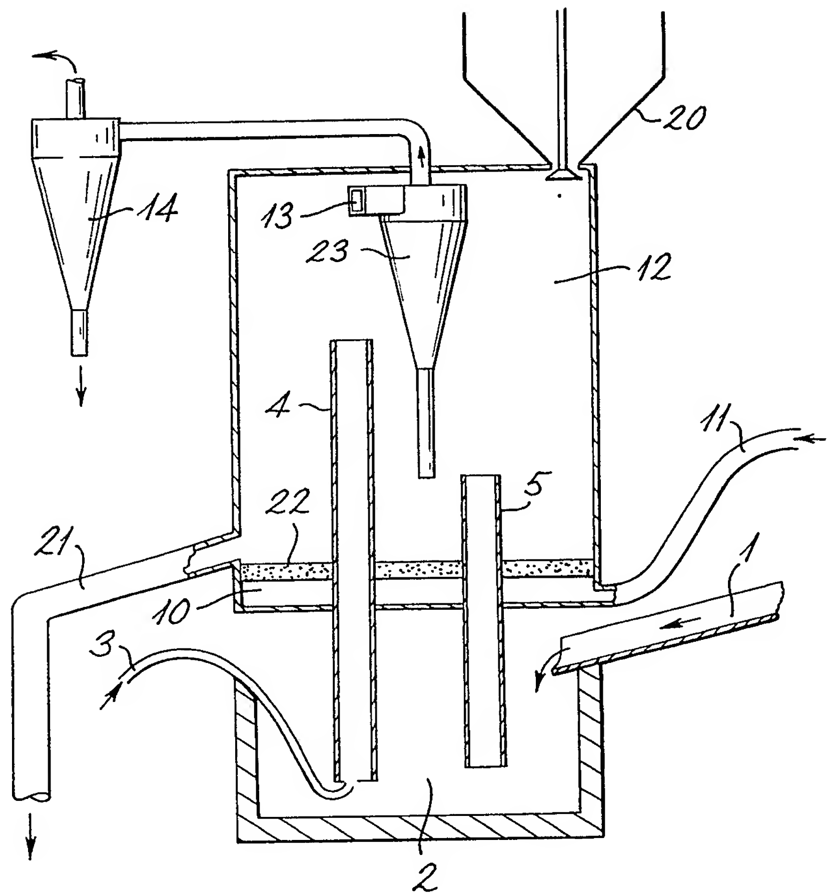

SPECIFICATION

Countercurrent gas treatment of metallurgical melts

This invention relates to a method and apparatus for countercurrent gas treatment of metallurgical melts.

UK Patent GB 2048309 describes a method of recovering metals from sulphide ores by forcibly circulating a molten sulphide carrier composition through a number of stations in turn. Forced circulation of a molten metallurgical phase in such a way opens up new processing horizons compared with the limited possibilities which prevail in convention furnaces. There, high turbulence and extensive back-mixing virtually preclude any real countercurrent contact between phases and to a large extent negate attempts at staging reactions such as volatiles removal in localised areas within a system. If on the other hand a molten matte, for example, is force-circulated at a rate many times the outflow of product as described in that Patent, so that closed loop circulation is achieved, chemical reactions can be staged advantageously both from the point of view of their chemistry and in the interests of energy conservation. Direct recovery of heat from exothermic roasting reactions and its transference as sensible heat in the flowing matte to sites of endothermic reduction and volatilisation are facilitated by forced circulation. One such endothermic volatilisation site can be a reduced-pressure vessel to remove volatile material from the melt, and the method and apparatus according to the invention could for example be used at such a site.

The invention provides apparatus for and a method of counter-current gas treatment of a metallurgical melt, comprising lifting the melt from a reservoir through a riser leg driven by a lift gas fed into the riser leg, the riser leg debouching into a reduced, pressure vessel, supplying a scavenging gas into the reduced-pressure vessel below the top of the riser leg, and maintaining the reduced pressure by extracting gaseous material from the reduced-pressure vessel above the scavenging gas supply. Normally, the gas phase is continuous in a major part of the reduced-pressure vessel. The lifted melt may be returned from the reduced-pressure vessel to either one or both of: the reservoir, and an off-take leading to collection or further processing. A return leg may be provided for the lifted melt to return to the reservoir, said return leg extending less high than the riser leg. There may be provided in the reduced-pressure vessel a static bed of solid packing elements which the lifted melt irrigates under gravity, the packing elements possibly being soluble or fusible in the melt. Alternatively, the packing elements could have a melting point slightly above the normal temperature of the vessel; they could then be melted down deliberately and removed whenever the bed starts to become blocked with accretions. The bed may be replenished, although this would rarely be necessary with an insoluble infusible packing and a non-accreting melt. Preferably, the extracted gaseous material is subjected to a separation treatment to remove entrained non-gaseous matter, and preferably the separation treatment also condenses entrained vapours of metallurgical substances. The separation treatment may be in two stages; firstly at vessel temperature, and secondly below the freezing point of the melt. Conveniently the reduced-pressure vessel comprises a gas-permeable floor for admitting the scavenging gas and ensuring its distribution across the reduced-pressure vessel. However, the floor could be solid and gas admitted through circumferential tuyeres. The bed if present can lessen recirculation and longitudinal mixing of the gas, (while assisting its orderly distribution), and can also break up the lifted melt into a more attenuated condition, thus in these two ways assisting the overall efficiency of the countercurrent contact.

Such countercurrent gas treatment may be for metal-winning or refining already-won melts, such is its wide range of applicability.

The invention will now be described by way of example with reference to the accompanying drawing.

Metallurgical melt, such as copper sulphide matte containing harmful impurities such as arsenic, antimony, bismuth and lead, enters, via a channel 1, a vessel 2 equipped with an inert lift gas lance 3 aimed at the base of a long snorkel 4 or feeding directly to the snorkel 4 leading upwardly out of the vessel 2. The snorkel 4 is not only long upwardly, but also is submerged deeply into the vessel 2 so that the lift gas establishes a considerable pumping head, this being advantageous in matte dispersion described later. The vessel has a second snorkel 5 also rising out of the vessel 2 but shorter. The snorkels 4 and 5 reach through a gas chest 10, fed by a scavenging gas from a pipe 11, into a reduced-pressure vessel 12. The vessel 12 is subject to suction through a gas off-take 13 which passes first through a cyclone 23 or similar device possibly within the hot vessel 12 to disengage molten droplets and then a dust-precipitating cyclone 14 or other cleaner outside the vessel 12 to a suction pump (not shown). The disengaged molten droplets are discharged at a low level in the vessel 12, still of course molten.

The vessel 12 has, at its top, a pressure-tight solids feed hopper 20 and, at its bottom, a melt off-take 21. A gas permeable floor or packing support 22 through which the snorkels 4, 5 pass forms both the base of the vessel 12 and the roof of the gas chest 10. If the floor 22 is liquid-permeable or absent, the snorkel 5 need merely be a drain hole in the roof of the vessel 2. However, the relative

heights of the snorkel 5 and the off-take 21 should be chosen to suit the process, espcially if two immiscible liquids will be present and are to be separated.

In use, the molten copper sulphide matte preferably with a very low copper-metal thermodynamic activity and a relatively high sulphur activity enters the vessel 2 and is lifted by the inert gas through the lance 3 into the reduced-pressure vessel 12. On emergence into that vessel, the matte is dispersed by the sudden pressure decrease into high-surface-area droplets, which after initial upwards flight fall down towards the floor 22. Meanwhile, however, the scavenging gas exudes through the floor 22 upwardly into the vessel 12, contacting the descending matte droplets in countercurrent fashion and removing the volatile components of the matte, such as certain sulphides such as of arsenic, antimony, lead and bismuth. A high copper-metal thermodynamic activity would have had detrimental effects on vaporisation of these impurities, it being well known that this high activity would depress the metalloid sulphide vapour pressure. These, when extracted through the off-take 13, may be condensed (or absorbed, into some solvent such as molten lead) and removed from the entraining gas. The fallen droplets accumulate on the floor 22 (which is impervious to them) and return via the snorkel 5 to the vessel 2 or leave through the off-take 21.

Optionally, the countercurrent contact is enhanced by a packed bed of for example shredded steel scrap or lump coke resting on the floor 22. Descending droplets will irrigate the bed packing elements without undue coalescence at low flow rates but forming thick rivulets at higher flow rates, flowing in either case countercurrently to ascending scavenging gas; the gas phase is continuous except for any possible shallow pool of liquid on the floor 22. The turbulence caused by passage of gas bubbles upwardly through such a pool can be advantageous. Some packings will eventually dissolve in a typical sulphide matte, and therefore are replenished from time to time through the hopper 20, without interrupting the process.

The scavenging gas may be reactive with the molten material, for example sulphur, chlorine or hydrogen, which may be diluted with a non-reactive gas, or may be non-reactive. The lift gas may be the same or different, preferably however non-reactive with the molten material, such as nitrogen or argon.

In an alternative version (not shown), the floor 22 is absent, so eliminating the gas chest 10. The packing elements rest directly on a deck which may or may not be formed by any ceiling of the vessel 2 and are fed with scavenging gas from tuyeres disposed round the circumference of the floor. This version may for example be used for directly winning zinc and lead from a sulphide matte, this operation being facilitated by having a high copper or iron activity. Molten elemental copper may be added to assist this process. Bearing in mind the mutual solubility of copper and copper sulphide, a high circulation rate in a closed circuit relative to the quantity of zinc/lead metal produced keeps the copper activity high provided that copper metal or copper-saturated matte is being produced at some part of the circuit and keeps the effect small of incremental additions of sulphide minerals fed to the process. This is the opposite of the case where the objective was to produce copper/nickel metal product, in which case the incremental effect of addition of sulphide minerals will have a marked effect in depressing the metal activity provided the circulation rate is low, and thus providing the conditions for the effective volatilisation of impurities such as arsenic. Removal from the matte of the impurities is essential before the circulating melt reaches the station at which copper/nickel metal is produced, otherwise the impurities will contaminate the product.

Thus it will be appreciated that the method and apparatus are applicable to direct metal winning from ore in which case the objective is to recover, as a product, volatile metals such as zinc and lead. The method and apparatus are also particularly suited to the treatment of metallurgical melts containing harmful volatile impurities, in which case the primary aim is to refine the metallurgical melt so that it meets desired low levels of impurities.

CLAIMS

1. A method of countercurrent gas treatment of a metallurgical melt, comprising lifting the melt from a reservoir through a riser leg driven by a lift gas fed into the riser leg, the riser leg debouching into a reduced-pressure vessel, supplying a scavenging gas into the reduced-pressure vessel below the top of the riser leg, and maintaining the reduced pressure by extracting gaseous material from the reduced-pressure vessel above the scavenging gas supply.

2. A method according to Claim 1, wherein the gas phase is continuous in the reduced-pressure vessel.

3. A method according to Claim 1 or 2, further comprising returning the lifted melt from the reduced-pressure vessel to either one or both of: the reservoir, and an off-take leading to collection or further processing.

4. A method according to Claim 3, wherein a return leg is provided for the lifted melt to return to the reservoir, said return leg extending less high than the riser leg.

5. A method according to any preceding claim, further comprising providing in the reduced-pressure vessel a static bed of solid packing elements through which lifted melt flows under gravity.

6. A method according to Claim 5, wherein

said solid packing elements are soluble or fusible in said melt.

7. A method according to Claim 6, further comprising replenishing the bed.

8. A method according to any preceding claim, wherein the extracted gaseous material is subjected to a separation treatment to remove entrained non-gaseous matter.

9. A method according to Claim 8, wberein the separation treatment also condenses entrained vapours of metallurgical substances.

10. A method according to Claim 1, substantially as hereinbefore described with reference to the accompanying drawing.

11. Apparatus for countercurrent gas treatment of a metallurgical melt, comprising a reservoir for the melt, a riser leg from the reservoir to a reduced-pressure vessel, a lift gas feed into the riser leg, a scavenging gas supply into the reduced-pressure vessel below the riser leg exit, and a gas extractor for maintaining the reduced pressure extracting gas from above said supply.

12. Apparatus according to Claim 11, further comprising a return leg for returning melt from the reduced-pressure vessel to the reservoir or an off-take for removing melt from the apparatus or both.

13. Apparatus according to Claim 12, wherein the return leg extends less high than the riser leg.

14. Apparatus according to any of Claims 11 to 13, further comprising a static bed of solid packing elements in the reduced-pressure vessel.

15. Apparatus according to Claim 14, further comprising means for replenishing the bed.

16. Apparatus according to any of Claims 11 to 15, further comprising a cleaner for the gas being extracted from the reduced-pressure vessel.

17. Apparatus according to any of Claims 11 to 16, wherein the reduced-pressure vessel comprises a gas-permeable floor or tuyeres around the edge of an impermeable floor for admitting the scavenging gas.

18. Apparatus according to Claim 11, substantially as hereinbefore described with reference to the accompanying drawing.

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TITLE: Gas scavenging of metal melts by primary melt into reduced pressure vessel whilst passing scavenging gas upwards to remove volatiles

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PATENT-ASSIGNEE: NAT RES DEV CORP[NATR]

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ABSTRACTED-PUB-NO: GB 2193975 A

BASIC-ABSTRACT:

Gas treatment of a metallurgical melt is effected by raising the melt from a reservoir to a pressure reduced vessel by means of light gas fed through a riser tube, and supplying a scavenging gas into the bottom of the pressure reduced vessel below the top of the riser tube, whilst maintaining the reduction in pressure by exhausting the gas from the vessel. The lifted melt falls through a bed of soluble packing elements to either the reservoir or to a collector; and entrained solids and vapours are removed from the gases and returned to the melt.

Appts. comprises a melt reservoir, a pressure reduced vessel, lift gas feed and riser tube, scavenging gas supply and gas extraction plant.

USE/ADVANTAGE - The method and appts. are useful in metal and are refining, providing a continuous, closed loop gas scavenging system which is efficient in both the recovery of reinfined metals and in process heat utilisation.

TITLE-TERMS: GAS SCAVENGER METAL MELT PRIMARY REDUCE PRESSURE VESSEL PASS UP REMOVE VOLATILE

DERWENT-CLASS: M25

CPI-CODES: M25-F; M25-J;

SECONDARY-ACC-NO:

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